catch up on my writing.

What do you think are the big questions in your field in the short and long term? Over the next couple of decades, we will see major advances integrating data on rates and patterns of genomic and phenotypic evolution. For example, are phenotypic differences between species largely the result of a few tens, or many thousands, of accumulated mutations? As Mary-Claire King and Allan Wilson asked about humans and chimps (1975, Science *188*, 107–116), might a relatively few regulatory mutations have made us who we are? Whole-genome sequences and expression arrays, coupled with rigorous experiments in model organisms, should fuel these advances. Over the much longer run, and assuming the human species does not destroy itself first, there is the possibility that humans will create artificial life forms that have a major impact on the future course of evolution. Humans have always been inventors, and I can see no fundamental obstacle to extending this creativity to novel life forms. Will this A-Life be carbon-based or otherwise? Will it be completely autonomous or live only in symbiosis with human civilizations? Although some forms of A-Life might become threatening over the long run, as a scientist I feel incredibly lucky to be present at the dawn of these new creations. Using digital organisms, we can study the ecology, genetics and evolution of brand-new life forms. In a way, it's like being transported back in time to study the earliest stirrings of organic life. On top of that, even these primitive A-Life systems enable us to do serious science right now, by providing a platform for experiments that we could not otherwise perform and thereby leading us toward new ideas about life and evolution.

Department of Microbiology & Molecular Genetics, Michigan State University, East Lansing, Michigan 48824, USA.
E-mail: lenski@msu.edu

All of a flutter

The fluttering flight of butterflies is characteristic of these insects but belies the fact that most species are competent or strong fliers with several members carrying out spectacular migrations. However, new work by a team led by Angel Viloria based at the Natural History Museum in London, report in the Proceedings of the Royal Society published online, the first potentially flightless butterfly.

The team has been studying species of butterfly in the genus *Redonda* which are found in the high Andean grasslands of Venezuela. Males of three species and two sub-species were all competent fliers but females showed a progressive reduction in flight ability and wing size along a gradient across the region compared with the males. In the species described in the report, *Redonda bordoni*, there was a very marked difference in wing size between males and females.

In fieldwork, the researchers found that when females were disturbed they simply walked away and never flew. When one female was lifted from the turf and dropped, she simply fluttered to the ground and walked off.

The condition of flightlessness, known as brachyptery, has occurred apparently independently a number of times amongst the moths but has never been observed before in the 20,000 known butterfly species. As well as reduction in size of the wings, female *R. bordoni* also show changes in wing structure and abnormal venation.

The researchers believe environmental conditions may be responsible for the females' evolution towards flightlessness. The larval grass food plants are abundant in the turf so the females have little need to seek them out. The females were observed just to scatter their eggs while crawling around the vegetation. Also climatic conditions include frequent very strong winds and fog at the 3,000 metre altitude habitat they inhabit which makes flying difficult. So flying may be energetically costly whereas flightlessness allows females to divert more energy into egg production.

But the females' wings appear still to have one key function. The researchers found that the insects are extremely difficult to spot with wings closed crawling amongst the turf. It looks as if they still use the silver colour on the upper surface of their wings to attract their fully airborne potential mates at breeding time.

Grounded: New work suggests that females of the Andean butterfly *Redonda bordoni*, shown here, are flightless. (Photo: Jose R. Ferrer-Paris.)